Chapter 4
Coastal Erosion Assessment and Planning

Introduction

The Illinois coast of Lake Michigan is a dynamic setting influenced by waves, ice and changing lake levels. The potential for coastal erosion exists along nearly the entire Illinois coast. This chapter addresses the coastal erosion issue, how it has been addressed in the past, and how coastal erosion assessment and planning will occur in the ICMP.

Background

Two aspects of coastal erosion along the Illinois coast are important as a framework for understanding past, present and future erosional trends.

Coastal Erosion in the Natural Setting

Prior to any human modifications, the natural setting along the Illinois coast was nearly all erosional (Chrzastowski, Thompson and Trask 1994). There was an abundant supply of littoral sand moving along the shore. However, this sand was in transport to a depositional zone along the central Indiana coast. The exception to the erosional trends was the southern part of the Zion beach-ridge plain from near the mouth of Dead River southward to the North Chicago shoreline. This was the state's only accretional shore. The accretion resulted from the southward translation of the beach-ridge plain.

Lake Level Influence on Coastal Erosion

Erosion along the Illinois coast gains considerable public and media attention during times of high lake levels. High water causes partial to total submergence of some beaches, storm waves can damage and overtop shore structures, and localized coastal flooding may occur. A common misconception is that coastal erosion is limited to times of high lake levels. The reality is that erosion can be an ongoing process regardless of lake level. Changing lake level simply shifts the erosion zone either landward or lakeward.

Four Categories of Illinois Coastal Erosion

Four categories of coastal erosion have been and continue to be an issue along the Illinois Lake Michigan coast and the inland waterways. These correspond to different locations on the topographic/bathymetric profile:

- Shore erosion
- Bluff erosion
- Lakebed erosion
- Waterway bank erosion

Shore Erosion: Shore erosion refers to the erosion of the exposed beach or land area adjacent to the shoreline. Shore erosion results in a landward translation of the shoreline as well as loss of beach area and loss of beach sand volume. A related process to shore erosion is the damage and deterioration of engineered structures that occur along the shore such as revetments, riprap, groins, bulkheads and breakwaters. Because of the important role of shore-protection structures along the Illinois coast to stabilize the land/water interface, damage and deterioration of these structures can be equally important as any erosional loss of beach area or land area.

Bluff Erosion: The natural setting along the Illinois bluff coast was one of nearly continuous bluff erosion (*e.g.,* Atwood and Goldthwait 1908; Illinois Division of Waterways 1958). The bluff erosion

commonly involved wave erosion cutting into the toe of the bluff and undermining the bluff slope. The bluffs could also erode due to the influence of either surface runoff or ground water respectively moving over or through the bluff materials. The late 1970s to 1990s saw substantial shore protection installed to halt bluff erosion. By 2000, a survey of the bluff coast determined that wave-induced bluff erosion was active along no more than about 600 feet of the entire bluff coast (Chrzastowski 2000).

Lakebed Erosion: The term *lakebed erosion* refers to underwater erosion across the bed of the lake. This erosion does not refer to the sand or gravelly sand that may occur along the lake bottom. Lakebed erosion refers to the erosion across the cohesive layers of glacial till or clay that underlie the sand. This type of erosion is also referred to as *lakebed downcutting*, or simply *downcutting* (U. S. Army Corps of Engineers 2006). The cause is wave and current action as well as ice.

Lakebed erosion is non-reversible erosion because the loss of the cohesive material cannot be replaced other than by a new glacial episode. The long-term impact of lakebed erosion is the lowering of the lake-bottom profile. As a result, deeper water occurs closer to shore and the profile is steeper between the beach and nearshore. The deeper water and steeper profile allows larger waves to impact the shore, which can increase the potential for erosion along the beaches and along the toe of the bluffs.

Waterway Bank Erosion: The banks along the inland waterways are subject to erosion by undermining and slope instability. Bank erosion can be from natural processes or human activity such a boat wakes.

Historical Mitigation of Coastal Erosion

Mitigation of coastal erosion along the Illinois coast has taken a variety of approaches through time. Hardening the shore with engineered structures has been the most common practice. In recent decades, there has been greater interest in using "soft" solutions such as beach nourishment or beaches in combination with hard structures built to retain sand volume.

Shore-Protection Structures: A variety of shore-protection structures occur along the Illinois coast such as groins, riprap, revetments, and breakwaters. Many of the early shore-protection structures relied on timber to form the walls for rock-filled cribs in breakwaters and groins. Steel sheetpile is now the primary material for facing groins, jetties, and the base of stepped revetments along the Chicago lakeshore. Quarry stone and reinforced concrete are also common materials.

Headland Beach Systems: A type of shore protection that also provides recreational and aesthetic benefits is engineered pocket beaches held by groins or rubble-mound breakwater headlands. These headland beach systems have the advantage of: 1) creating a contained beach that is not dependent on any influx of sand supply from littoral transport, and 2) creating a beach that will have minimum loss of sand to littoral transport. The headland beach systems have been used extensively along private residential properties of the bluff coast.

Lakefill: Filling into the shallow nearshore area to create new land and establish a new more lakeward shoreline position has been used as a means of shore protection at many sites along the Illinois coast, particularly along the Chicago lakefront. The lakefill results in a new shoreline edge that can be built in a durable way to withstand direct wave and ice impact, and thus be more erosion-resistant than the pre-lakefill shoreline.

Beach Nourishment: Beach nourishment is a maintenance issue along many of the municipal beaches along the Illinois coast and, to a limited degree, along private lakeshore properties. The most rigorous

beach nourishment is done at Illinois Beach State Park. Maintaining the state park shore to be free of any additional shore protection or offshore structures is a long-term coastal management objective for the state park (Illinois Department of Natural Resources 2001).

Permitting Projects for Coastal Erosion Control - *General*

Two authorities are responsible for reviewing and permitting construction along the Illinois coast having the purpose of controlling coastal erosion. On the state level, the permitting is done by the Office of Water Resources (OWR), Lake Michigan Management Section, of the Illinois Department of Natural Resources (IDNR). On the federal level, permitting is done by the U. S Army Corps of Engineers (USACE), Chicago District Regulatory Branch. In general, for both the IDNR and the USACE, no projects are permitted that are deemed potentially disruptive to the movement of littoral transport along the beaches and nearshore. An exception to this restriction might include structures that will trap sand but will have a sand management plan, which provides for the bypass or backpass of sand that is captured by the structures.

A requirement of permitting by the IDNR is that any shore protection that involves building a beach include the filling of the beach to the maximum capacity of computed sand retention and then, in addition to this capacity volume, include a 20 percent overfill. This overfill assures available sand if needed for any unforeseen adjustment to the beach and nearshore profile. The IDNR distributes public notices concerning any permit applications, allows for the public review of plans for the proposed project, and allows a 30-day period for written comments. No work can begin until the permit is issued.

The wide range in historical lake-level fluctuation in Lake Michigan (6.3 feet; see Chapter 2) results in the need for some shore protection that has direct interaction with lake water only during times of extreme high lake levels. An example is the revetments built at the toe of the bluffs along the bluff coast. Although these revetments may have some wave impact during extreme storms, commonly a beach may exist adjacent to the revetment, and only at times of higher lake levels might the still water be in contact with the structure.

The permitting process allows shore-protection structures for both private and public lakeshore property to be built extending onto the lake bottom. This is despite the lake bottom being state land held in public trust. Filling of lakeshore land is permitted by Illinois state law conditional that the filling serves a public benefit. An example is the creation of lakeshore parkland such as the parkland of the Chicago lakefront.

For both the IDNR and the USACE, Chicago District, the upper limit to which state and federal permitting of lakeshore construction applies is the Ordinary High Water Mark (OHWM). This is the typical or “ordinary” high level to which the lake water will rise in its long-term fluctuation. Most often, lake level is below this elevation.

In some coastal states, the OHWM defines the boundary between private property and public beach and water. This is not the case in Illinois. Private property and riparian rights along the Illinois coast extend to the calm water shoreline and migrate landward or lakeward with changing lake level (Illinois case law: Brundage v. Knox, 1917).

As defined by the U.S. Army Corps of Engineers, the OHWM along the Illinois coast is 581.5 feet (177.2 m) relative to the International Great Lakes Datum (IGLD) 1985. Only shore construction that occurs below this elevation is subject to permitting by the IDNR and the USACE.

Permitting Projects for Coastal Erosion Control - *Specifics*

Both private and public construction activities in Lake Michigan require Illinois Department of Natural Resources, Office of Water Resources' (IDNR/OWR) authorization pursuant to the Rivers, Lakes and Streams Act of 1911 [615 ILCS 5] and IDNR/OWR Part 3704 "Regulation of Public Waters".
Both the IDNR/OWR and the U.S. Army Corps of Engineers use the ordinary high water elevation, 581.5 ft. International Great Lakes Datum-1985 (IGLD-85) to determine whether a permit is required. Construction activities proposed at or lakeward of that elevation require IDNR/OWR authorization. IDNR/OWR permits are issued jointly with the Illinois Environmental Protection Agency (IEPA). The following two types of shore protection permits are issued for work in Lake Michigan:

General Permits No. 1-LM are issued for minor shore parallel protection projects that do not exceed a length of 300 ft., and which meet the special conditions of that general permit. Examples of these projects would be stone revetments or steel sheet pile bulkheads built at the toe of a bluff. This permit does not require the issuance of a public notice but does require IEPA approval.

All other types of shore protection projects proposed within or adjacent to the waters of Lake Michigan and below an elevation of 581.5 IGLD-85 requires a regular permit from the Department. Examples of these types of projects include but are not limited to, revetments (longer than 300 ft.), seawalls/bulkheads (longer than 300 ft.), groins, breakwaters/offshore structures, beach nourishment, piers and modifications to existing structures. These types of projects require the issuance of a 28-day public notice. These projects are reviewed by IDNR/OWR personnel for compliance with Part 3704 Rules, and also require IEPA approval prior to a permit being issued.

Projects proposed outside the waters or the influence of the coastal processes of Lake Michigan and which are entirely above the Department's regulatory elevation of 581.5 IGLD-85 do not require a permit. These include projects on a bluff and areas upslope, or landward of the existing bluff toe or bluff toe protecting structure. Projects on bluffs or otherwise outside the jurisdiction of the IDNR may still be within the ICMP boundary and thus must be undertaken in accordance with ICMP enforceable policies. Also, maintenance work associated with the restoration of an existing permitted project to its original specifications does not require a new permit.

As noted earlier, IDNR/OWR personnel must determine whether a proposed shore protection project complies with the Department's Part 3704 Rules. Section 3704.70 specifically prohibits the conversion of public waters to private land by filling; however fill material may be placed in public waters for such things as bank, shore or bluff protection and beach nourishment. Section 3704.80(a) specifies that the proposed activity must not: 1) cause an obstruction to, or interference with, the navigability of a public body of water, 2) result in an encroachment on a public body of water, 3) cause an impairment of any rights, interests or uses of the public in any public body of water or to its natural resources, and 4) cause bank or shoreline instability on other properties. Section 3704(b) outlines the additional information an applicant should submit if the proposed activity might cause one or more of these impacts. Section 3704.90 contains the standards the Department uses to determine whether a permit should be issued.

Generally, proposed offshore structures should be located as close to shore as possible and be no larger than needed to protect the applicant's property. The size of the structure including height, length, etc. should be comparable to adjoining structures in the area. Where possible, the project should provide some type of reasonable access over or around it on the landward side.

Upon receipt of an application, an initial review will determine the need for clarification, or additional information, if any. At the same time, the applications are forwarded to the Illinois Department of

Natural Resources, Office of Realty and Environmental Planning for their review. The applicant is responsible for contacting the Illinois Historic Preservation Agency for any requirements they may have. If the initial review determines that a project will not require a permit, the Department will inform the applicant by letter.

If a project requires a Regular Permit, a public notice will be issued. For shore protection projects, the minimum public notice period will be 28 days. This public notice period may be extended if needed to allow interested parties the opportunity to prepare and submit comments.

Once the Department has received all the required information including public notice comments and responses, it will determine whether the proposed project is in compliance with the provisions of our Part 3704 Rules. If the project is found to be in compliance with these rules, an IDNR/OWR Permit will be issued. If it is found not to be in compliance with the Part 3704 Rules, a denial letter will be issued. All denials are issued without prejudice and include a detailed explanation.

ICMP Coastal Erosion Assessment and Planning

Assessment

In assessing coastal erosion issues, the ICMP will rely on data and analysis of coastal erosion from appropriate local, state and federal agencies, qualified university coastal researchers, and Illinois state-licensed engineers and/or geologists trained and experienced in coastal studies. The type of data collection will include the spectrum of coastal data needs such as coastal aerial and satellite imagery, topographic and bathymetric mapping, sediment analysis, stratigraphic study, and data on wave, lake-level and ice dynamics. A goal of the ICMP will be the development of an Illinois coastal GIS database of all erosion-related data.

Planning

The ICMP decision process for planning responses to coastal erosion will build from a scientific and technical framework of several key perspectives regarding coastal processes along the Illinois coast. These are:

- The Illinois coast was nearly all erosional in its pre-development setting. The exception was the southern end of the Zion beach-ridge plain. Human activity has been responsible, in places and at times, to focus and exacerbate erosion. However, the human erosional influence is additional to naturally occurring erosion.
- Waves are the dominant agent of Illinois coastal change. Fluctuating lake levels, changing sediment budgets, and ice dynamics all contribute to change. However, waves provide the energy to move sediment and ice and cause the impact energy against shore structures.
- Lake-level change is a continuous and natural process with various times scales (hourly, daily, monthly, seasonally, yearly, decadal and geologic). Erosion planning needs to include consideration of future lake-level change while also recognizing the uncertainty in long-term lake level prediction.
- Waves are the agent for moving sediment along the Illinois coast. Sediment can be moved northward by waves from the southeast quadrant or southward by waves from the northeast quadrant. Both transport directions occur. Because of the greater fetch for northerly waves, these produce the net and regional littoral transport which is from north to south.
- The Illinois coast has experienced reduction in the volume of littoral sand in transport during historical time. This is a result of both reduced sediment input from shore and bluff erosion and

structural blockage and entrapment of littoral sand. Conservation of existing sand resources is critical.

- The Illinois coast is what is geo-technically called a "cohesive coast." This means the upland to nearshore profile primarily consists of cohesive materials (glacial till). Any sand or gravel along the beaches and nearshore are a lens or veneer superimposed on the cohesive material. Erosion of the cohesive materials is non-reversible.

The areas of greatest concern for coastal erosion will change with time, and the ICMP efforts toward erosion management will adjust accordingly. For example, in the 1970s, most of the bluff coast was a critical erosion area, and during the record high lake levels of 1986-1987, erosion of beaches, parkland and deteriorated shore protection was a major concern along the Chicago lakefront.

Although the focus on erosion issues will change with time and localized erosion "hot spots" may intermittently come to the forefront, the ICMP will maintain a continuing focus on two erosion areas of critical concern. These will have a priority for erosion mitigation and long-term management.

1) Illinois Beach State Park: This park lakeshore is dependent on an adequate supply and transport of littoral sand to maintain a balanced sediment budget. The most severe erosion is presently in the North Unit, but the potential for severe erosion exists along all of the state park shore if a littoral sediment supply is deprived. The ICMP will not fund beach nourishment, but the ICMP will have a priority concern for other ways that are ICMP compliant to assist the IDNR erosion monitoring and management.

2) Nearshore Lakebed: Depletion of sand cover across nearshore lake bottom and erosion of the glacial till lakebed will be a sustained management concern. Evaluation and monitoring of this erosion will be promoted and supported. This is an erosion process that has implications for permanent change to the morphology of the Illinois coast.

The ICMP management of coastal erosion will involve partnerships with appropriate municipal, county and state agencies concerned with coastal erosion along the different segments of the Illinois coast. Partnerships will also be developed with governmental agencies having responsibility for erosion management along the inland waterways.

Chapter 4 - References

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